Microscopy Applications for Materials Science Research and Development at Sandia/CA

The Electron Optics (EO) facility in the Department of Analytical Material Science, 8723, is a central technical facility providing material characterization support for all programs at SNL/CA. There are four major microscopy application areas: optical metallography (OM), scanning electron microscopy (SEM), electron probe microanalysis (EPMA), and transmission electron microscopy (TEM). Each microscopy instrument possesses its own characteristic resolution and each microscope uniquely configured to capture specific scientific information using the principles of electron optics detailed in Figure 1. Combining all four microscopy techniques allows the EO group to obtain the physical, chemical, and metallurgical properties of a solid material, discerning features with sizes on the order of Angstroms (1×10-8cm). The group collaborates regularly with principal investigators for weapons-related material research, as well as investigating issues related to fuel combustion, site-wide infrastructure, and ES&H. The following are examples of microscopy applications that provide material science insights making a significant programmatic impact on the related project.

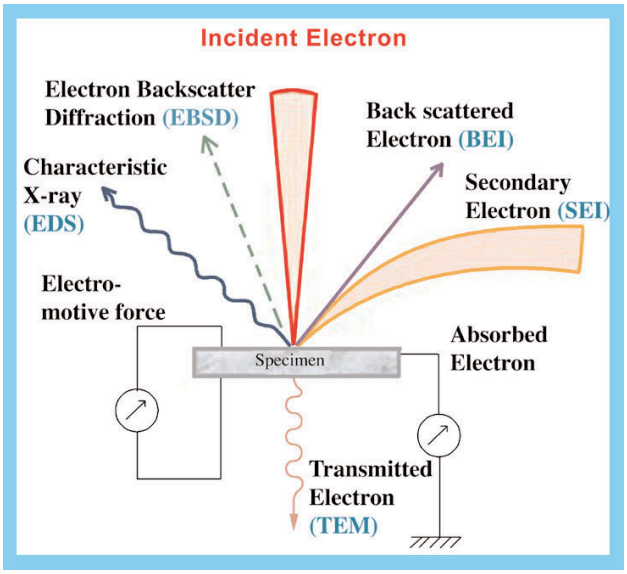
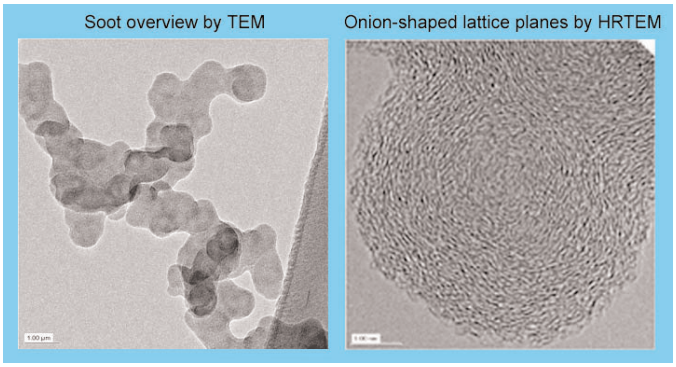
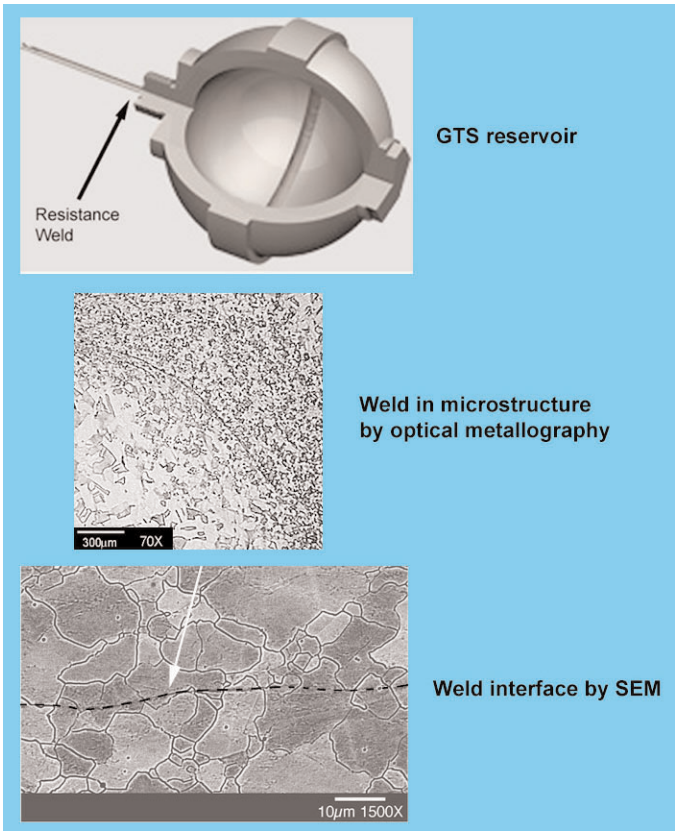


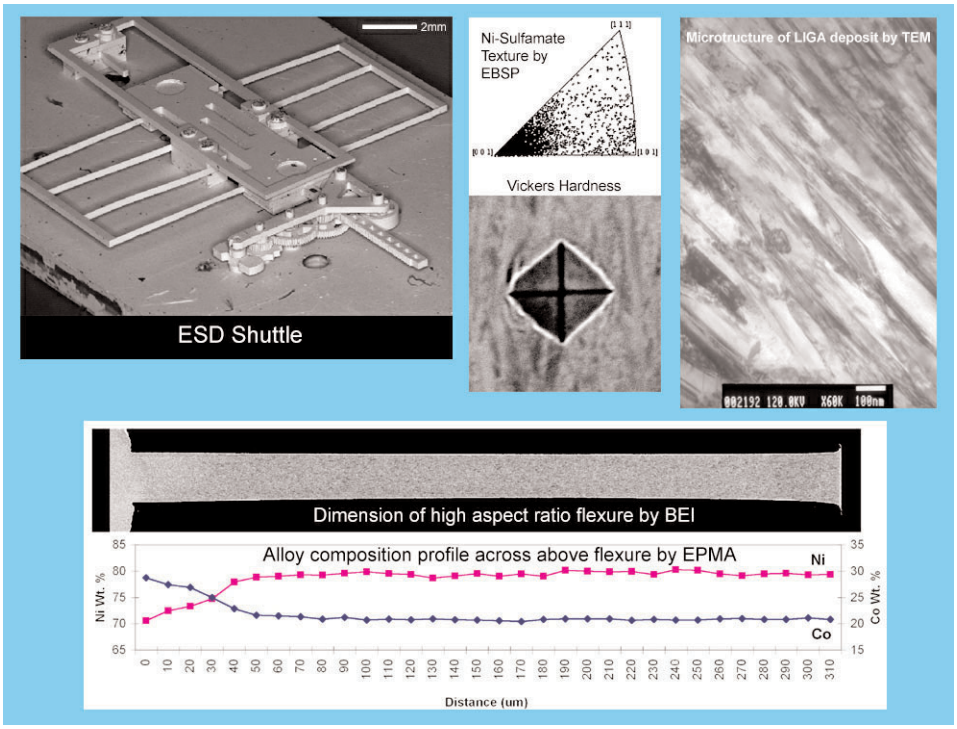
Figure 1. Principles of electron optics.



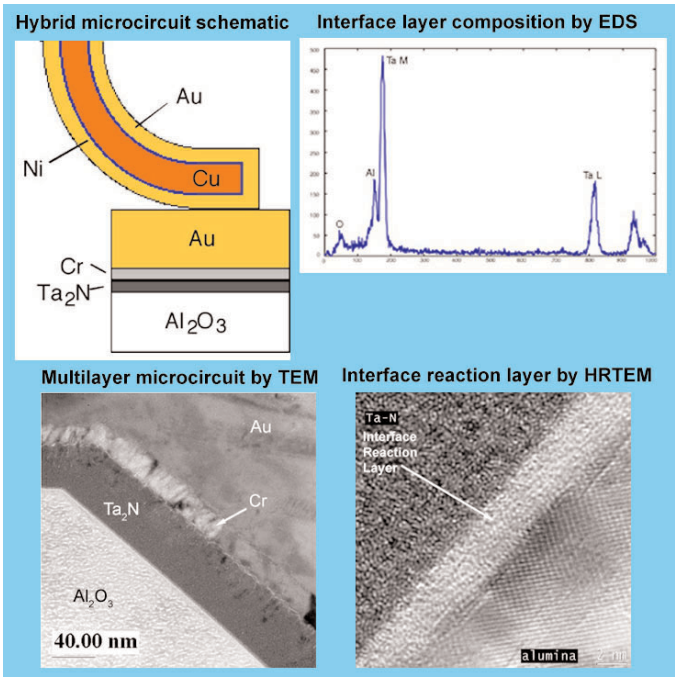
TEM and HRTEM images together provide a thermal history for the nano-size soot particles formed during fuel combustion. Knowledge of the soot primry particle size, as revealed through TEM examination of soot aggregates, is essential for the development of accurate rate expressions for soot mass growth and oxidation. The nanostructure of soot particles, as revealed through high-resolution TEM (HRTEM) imaging, impacts the chemical reactivity and the intrinsic optical properties of the soot. Recent work at Sandia has demonstrated the densification of the soot carbon structure as soot is emitted from the top of smoking diffusion flames. (**Energy Research Program**)



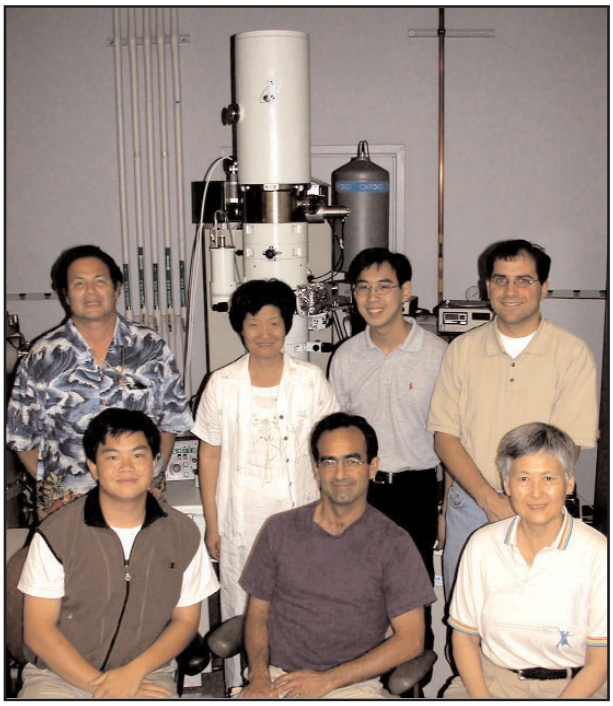
Light-optical images of a weld's cross-section allow researchers to examine weld quality, integrity, and re-crystallization at the weld interface. (**Weapon Research Program**)



Combining OM, SEM, and EPMA analyses enables scientists to gain a better understanding of the critical material's properties (hardness, texture, grain structure, and alloy composition) throughout a micron-size electrodeposit in the LIGA ESD shuttle. (**Prototype LIGA-Microsystem Development Program**)



The combination of TEM-bright filed (BF) and TEM-high resolution atomistic (HRTEM) images allows us to study the thin film's microstructure, bond integrity, and metallurgical reaction(s) at the multi-layers thin film interfaces in the hybrid microcircuit. (**Enhanced Surveillance Program)**



Electron Optics Staff -From left standing: Andy Gardea (OM), Nancy Yang (Leading staff), Markus Ong (student intern), Gene Lucadamo (TEM),
From left sitting: Bryan Lin (student intern), Jeff Chames (SEM), and JaLee Yio (EPMA)